

## CLAIMS

What is claimed is:

1. An air cleaner comprising a cylindrical housing extending axially along an axis and having a tangential inlet and having an outlet, an annular filter element in said housing and having a dirty side receiving dirty air from said tangential inlet and having a clean side delivering clean filtered air to said outlet, such  
5 that air entering said housing through said tangential inlet flows along an interior surface of a sidewall of said housing in a helical pattern about said axis, and flows radially inwardly through said annular filter element, an annular shielding sleeve circumscribing said annular filter element and spaced radially inwardly of said interior surface of said sidewall of said housing by a radial gap defining an annular  
10 flow channel between said sleeve and said interior surface of said sidewall of said housing, said filter element having an axial end covered by an axial end cap at said tangential inlet, said end cap having an axial height, said tangential inlet having an axial height greater than said axial height of said end cap, said sleeve having an axial height greater than or equal to said axial height of said end cap and less than said  
15 axial height of said tangential inlet.

2. The air cleaner according to claim 1 wherein said housing has a ramp in said channel directing air flow along said helical pattern, said ramp having a leading end and a trailing end, said ramp having a minimum axial height at said leading end, said ramp having a maximum axial height at said trailing end, wherein  
5 said axial height of said sleeve is less than said maximum axial height of said ramp.

3. The air cleaner according to claim 2 wherein said ramp has a first segment extending circumferentially and axially along said sleeve from said leading end of said ramp to an intermediate portion of said ramp, and said ramp has a second segment extending circumferentially and axially beyond said sleeve from said  
5 intermediate portion of said ramp to said trailing end of said ramp, wherein said

intermediate portion of said ramp has an axial height equal to said axial height of said sleeve, and wherein the entire circumferential length of said second segment of said ramp from said intermediate portion of said ramp to said trailing end of said ramp has an axial height greater than said axial height of said sleeve.

4. An air cleaner comprising a cylindrical housing extending axially along an axis and having a tangential inlet and having an outlet, an annular filter element in said housing and having a dirty side receiving dirty air from said tangential inlet and having a clean side delivering clean filtered air to said outlet, such  
5 that air entering said housing through said tangential inlet flows along an interior surface of a sidewall of said housing in a helical pattern about said axis, and flows radially inwardly through said annular filter element, an annular shielding sleeve circumscribing said annular filter element and spaced radially inwardly of said interior surface of said sidewall of said housing by a radial gap defining an annular  
10 flow channel between said sleeve and said interior surface of said sidewall of said housing, said sleeve having an axial height tapered along a portion of its circumference at a location aligned with said tangential inlet, such that incoming air through said tangential inlet does not initially encounter a full axial height sleeve, but instead encounters a tapered sleeve of increasing axial height, whereby to reduce  
15 initial flow restriction.

5. The air cleaner according to claim 4 wherein said tapered portion of said sleeve has a leading end and a trailing end, said channel has a first circumferential section of increasing axial depth to air flow therealong from said leading end of said tapered portion of said sleeve to said trailing end of said tapered  
5 portion of said sleeve, and said channel has a second circumferential section directing air flow therealong from said trailing end of said tapered portion of said sleeve.

6. The air cleaner according to claim 5 wherein said housing has a

5 ramp in said channel directing air flow along said helical pattern, said ramp having a leading end and a trailing end, said ramp having a minimum axial height at said leading end of said ramp, said ramp having a maximum axial height at said trailing end of said ramp, wherein said second circumferential section of said channel directs air flow therealong from said trailing end of said tapered portion of said sleeve to said leading end of said ramp, and wherein said channel has a third circumferential section directing air flow therealong from said leading end of said ramp, said third circumferential section of said channel having decreasing axial depth to air flow therealong, such that air flow entering said tangential inlet encounters increasing axial channel depth along said first circumferential section of said channel and then is directed through said second circumferential section of said channel and then encounters decreasing axial channel depth along said third circumferential section of said channel.

5 7. The air cleaner according to claim 6 wherein said tangential inlet is axially between said leading end of said tapered portion of said sleeve and said trailing end of said ramp such that said leading end of said tapered portion of said sleeve and said trailing end of said ramp are on axially distally opposite sides of said tangential inlet.

8. The air cleaner according to claim 7 wherein said trailing end of said tapered portion of said sleeve and said leading end of said ramp are on circumferentially distally opposite sides of said tangential inlet.

9. The air cleaner according to claim 6 wherein the axial height of said sleeve at said trailing end of said tapered portion of said sleeve is less than the axial height of said ramp at said trailing end of said ramp.

10. The air cleaner according to claim 9 wherein said ramp has a

first segment extending circumferentially and axially along said sleeve from said leading end of said ramp to an intermediate portion of said ramp, and said ramp has a second segment extending circumferentially and axially beyond said sleeve from said  
5 intermediate portion of said ramp to said trailing end of said ramp.

11. The air cleaner according to claim 5 wherein the axial height of said sleeve at said trailing end of said tapered portion of said sleeve is less than the axial height of said tangential inlet.